Response to EPA Questions Regarding the Technical Memorandum titled *RM 10.9 Cap Active/Sand Layer Composition: Determination by Core Testing and Mass Balance*

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The CH2M HILL December 9, 2013 Technical Memorandum detailed the rationale for, and results of, the mass balance approach used by the CPG to determine whether placement of the RM 10.9 cap's active/sand layer met the design criteria. It also presented work performed outside the scope of the approved design, namely the preliminary results of carbon analyses collected from active/sand layer cores. Based on results from other sediment sites, EPA and its consultant acknowledged that the carbon data could vary as widely as +/- 50% from the actual values. Notwithstanding the significant uncertainty with sampling and analytical reproducibility, on a November 13, 2013 conference call, EPA directed the CPG to collect and analyze these samples. On the conference call, EPA's stated intention was to use these data to inform potential future capping on the Lower Passaic, not as acceptance criteria for the cap placement.

On Thursday, December 10, 2013 Stephanie Vaughn / EPA Region 2, provided four follow-up questions to the December 9, 2013 Technical Memo. The EPA questions and the CPG responses are presented below:

EPA QUESTION 1: *The active cap design and model calculations are based on a certain carbon mass in the cap. The 3-inch thick cap is derived based on AquaGate having a density of 80# per cubic feet to arrive at a certain carbon mass in the cap. If the AquaGate has only 72 lb per cubic feet, then the carbon mass in the AquaGate is correspondingly reduced. Even though we may meet the 3-inch thick requirement, we have not met the intent of the design (to achieve the carbon mass).*

CPG RESPONSE TO QUESTION 1:

The active layer chemical transport modeling performed to support the cap design was conducted using an AquaGate+PAC™ density of 65 lbs per cubic foot. This is the midpoint of the density that was provided by the vendor at the time of the modeling (See attached technical specifications sheet: AquaGate+PAC™ dry bulk density is reported as 60 – 70 lbs per cubic foot). The average density of AquaGate+PAC™ deployed during construction of the active layer was 72 lbs per cubic foot, over 10% higher than the active cap design and model calculation value. Since the carbon mass and AquaGate+PAC™ density are directly proportional, the applied active layer had over 10% more

carbon that the specified design. Carbon mass in the deployed AquaGate+PAC™ exceeds the basis of the design.

EPA QUESTION 2: *Regarding the total carbon analysis, without collecting a control sample (i.e., a sample of 30% Aquagate and 70% sand mixture from a bucket) as the baseline, we cannot tell if any carbon is lost during placement. This control sample was requested by EPA and discussed with the CPG. Please explain why it was not analyzed.*

RESPONSE TO QUESTION 2:

The laboratory has had extensive difficulties pre-processing the AquaGate+PAC™ samples for carbon analysis. The first two drying methods failed due to the complex matrix of the AquaGate+PAC™ product and related moisture retention issues. In addition, the samples could not be milled down to a powder for appropriate homogenization. At this time, the lab is still attempting to process and analyze samples given the difficulties in pre-processing the samples for carbon analysis.

It should also be noted that the preliminary data received and reported to date from the laboratory are incomplete, have not been validated, and the sample pre-processing and handling methods have not been investigated to establish whether the results reported by the laboratory are accurate (i.e., no testing has been done to quantify the amount of carbon lost during the pre-processing step). The entire package will be submitted when it is available. However, the purpose will be to evaluate if this methodology has any value going forward, not to prove what all the evidence points to, that the active layer was correctly placed. In the absence of further analytical verification testing and given the results at other sediment sites where carbon varied as much as +/- 50% from the actual values, it would be premature to use these data for anything other than qualitative evaluation at this time.

EPA QUESTION 3: *The CPG has performed a calculation showing a 30 v% Aquagate mixture should have 2.6% of carbon and a 25 v% Aquagate mixture should have 2.1% of carbon. The carbon results from the 5 core samples range from 1.7% to 2.3 %. Two of the 5 core samples did not meet the minimum requirement of 2.1% and the average of the 5 core samples do not meet the average requirement of 2.6%.*

RESPONSE TO QUESTION 3:

As discussed earlier, EPA acknowledged the carbon data could vary as much as +/- 50% from the actual values. The results of the tests likely reflect the inability of the laboratory to fully homogenize the sample prior to analytical testing. A comparison of these carbon values against the design criteria for purposes of establishing adequacy of the deployed carbon is technically unfounded and goes beyond EPA's original (November 13th, 2013) stated use for the data.

In addition, as noted in the December 9, 2013 Technical Memo, it is misleading to judge whether an adequate amount of AquaGate+PAC™ has been placed based solely on the % AquaGate+PAC™ in a sample without also correlating the % AquaGate+PAC™ with the thickness of the active/sand layer.

EPA QUESTION 4: *Based on the carbon analysis, it appears that the quantity of carbon in the Aquagate/sand mixture does not meet the design requirements of 2.6%. Therefore, the cap may not meet the stated design life of 250+ years. At a minimum, the CPG will need to recalculate the design life of the cap based on the actual sample results to see if it meets the design criteria.*

RESPONSE TO QUESTION 4:

There is no basis to recalculate the approved final design criteria of the cap to prevent breakthrough for at least 100 years (See Final Design sections 7.1 and 7.2.1). As designed and placed, the cap is expected to exceed the design criteria by preventing breakthrough for more than 250 years (See Final Design section 7.2.2.1). As discussed in the Response to Question 1, carbon mass in the deployed AquaGate+PAC™ exceeds the basis of the design since the modeling was performed with a lower AquaGate+PAC™ density than the deployed material. In addition, the amount of AquaGate+PAC™ and the active/sand layer thickness that was actually placed (as measured by approved QA/QC procedures) exceeded the final design values. Furthermore, as discussed in the Responses to Questions 2 and 3, the % carbon test results are not of sufficient data quality, and were never intended to be used for, comparison against design criteria.

CONCLUSIONS

All approved QA/QC measurements verify that the active/sand layer placement in the areas both north and south of the No Dredge Zone meet the requirements of the Capping Specifications based on the CPG mass balance approach as concluded in the December 9, 2013 Technical Memo (attached). There is no evidence that a significant amount of deployed active layer material was lost or transported outside the desired application area. That is, the real-time turbidity measurements showed no exceedances during placement and no visual turbidity plumes were observed during placement. All areas are now ready for the next step -- placement of the geotextile liner and armor stone layer.

ATTACHMENTS

AquaGate+PAC 10%

AquaGate+PAC™

Background

AquaGate+PAC (Powdered Activated Carbon) is a patented, composite-aggregate technology resembling small stones typically comprised of a dense aggregate core, clay or clay-sized materials, polymers, and fine-grained activated carbon additives.

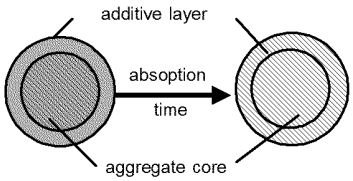

Figure 1. Configuration of PAC-coated particle.

AquaGate+PAC serves as a delivery mechanism to reliably place reactive capping materials into aquatic environments.

Product Specifications

Aggregate:	Nominal AASHTO #8 (1/4-3/8") or custom-sized to meet project-specific needs * Limestone or non-calcareous substitute, as deemed project-appropriate
Clay:	Bentonite (or montmorillonite derivative) ** Typically 15% by weight*
Activated Carbon:	Powdered – Iodine Number 800 mg/g (minimum) ⊙ 99% (minimum) through 100 mesh sieve ⊙ 95% (minimum) through 200 mesh sieve ⊙ 90% (minimum) through 325 mesh sieve ** Target 10% by weight - Range of 7.5 – 12.5% by weight*
Binder:	Cellulosic polymer
Permeability:	1×10^{-4} to 1×10^{-7} cm/sec (Variations will exist and permeability can be influenced by particle size distribution, placement, and cover materials – surcharge load)
Dry Bulk Density:	60 – 70 lbs/ft^3
Moisture:	10 – 12% (maximum)

AquaBlok® Composite Particle System

For more information, Contact AquaBlok, Ltd. at:

Phone: (800) 688-2649
Email: services@aquablokinfo.com visit us at our
Web: www.aquablokinfo.com

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Introduction

The CPG is using a mass balance approach to determine whether placement of the RM 10.9 cap's active/sand layer is adequate prior to placing the geotextile and armor stone layer. This memorandum provides the rationale for, and results of, the mass balance approach used by the CPG. All measurements based on the mass balance approach verify that the active/sand layer placement in the areas both north and south of the No Dredge Zone meet the requirements of the Capping Specifications. Therefore, both areas are ready for placement of the armoring layer.

During the November 13, 2013 "Weekly Management Review of Capping Activities" conference call hosted by Stan Kaczmarek/dmi (participants from EPA Region 2, CDM, dmi, CH2M HILL, and GLDD), EPA Region 2 directed that the CPG also take cores of the RM 10.9 cap's active/sand layer after placement and analyze for % total carbon (or similar analytical test procedure). In a follow-up phone call on the afternoon of November 13 hosted by EPA (participants from EPA Region 2, CDM, dmi and CH2M HILL), EPA stated that they wanted chemical analyses of the active/sand layer's carbon content in addition to the thickness QA/QC measurements specified in the approved design. CPG participants on that afternoon phone call expressed concern regarding the extent of the sampling and whether such sampling and analyses would be appropriately representative of the active/sand layer. EPA stated that sampling some of the same cores that would be used for QC purposes would be sufficient. EPA and its consultant further noted that they expected the % total carbon results could vary considerably – by as much as +/- 50% of the design value. However, EPA wanted these data to help evaluate the RM 10.9 active/sand layer placement and to inform potential future capping on the Lower Passaic River. Therefore, in addition to the mass balance analysis discussed above, this technical memorandum provides active/sand layer core sampling and carbon testing analytical results that have been received to date.

Measurement of Active Material

As discussed in an earlier technical memorandum (CH2M HILL December 3, 2013) cap performance is governed by the amount of AquaGate+PAC™ and sand that is present in the active/sand layer. The final design AquaGate+PAC™ content is a minimum average of 30% and a minimum of 25% by volume, which is based on an overall 10-inch-thick active/sand layer thickness. As noted in the December 3 technical memorandum, increasing the amount of sand, while maintaining the necessary amount of AquaGate+PAC™, enhances cap performance even though the % AquaGate+PAC™ decreases. Thus, % AquaGate+PAC™ measurements can be misleading as the

% AquaGate+PAC™ may appear to fall below design criteria if the sand thickness exceeds the 10-inch design thickness. Because the actual placed active/sand layer thickness can vary from the 10-inch thickness upon which the final design is based, it is necessa ry to measure the adequacy the active/sand layer composition by a method other than % AquaGate+PAC™.

The CPG determined that the most accurate and representative method to determine the adequacy of AquaGate +PAC™ placement is to use a mass balance approac h. The mass balance approach is used to calculate the equivalent depth of AquaGate +PAC™ application in an area. Results from both the mass balance approach and the carbon measurements required by EPA are presented in the following two sections.

Mass Balance Approach

The CPG utilized a mass balance approach for determining whether sufficient active/sand layer had been placed. The mass balance approach measured daily quantities of AquaGate+PAC™ deployed over a measured surface area and active/sand layer thickness. This mass balance method determines the actual placed AquaGate+PAC™ thickness and compares that value to the design criteria of a minimum average of 3.0 inches and a minimum of 2.5 inches of AquaGate+PAC™ (or a minimum average of 1.8 inches and a minimum of 1.5 inches of AquaGate+PAC™ in high subgrade areas). In addition, the active/sand layer thickness is evaluated to ensure its thickness meets design criteria of a minimum average of 10 inches and a minimum of 8 inches.

The mass balance approach is based on a large, accurate data set. That is, a known quantity of weighed sacks of AquaGate+PAC™ is deployed in a consistent, measured manner and the thickness of the resulting active/sand layer is measured. Importantly, utilizing the mass balance approach determines the adequacy of the active/sand layer placement in real-time without delaying cap placement while waiting for laboratory results.

AquaGate+PAC™ effective thickness results for the areas north and south and of the “No Dredge Zone” are presented in Table 3. All areas meet the AquaGate+PAC™ thickness design criteria. All active/sand layer thickness measurements also exceeded the minimum average of 10 inches (or 6 inches in high subgrade areas).

Table 3. Effective Thicknesses of AquaGate+PAC™

Date	*Volume of AquaGate+PAC™ Placed (cubic yards)*	*Area Covered by AquaGate+PAC™ (square feet)*	*Effective AquaGate+PAC™ Thickness * (inches)*
	Area South of the No Dredge Zone		
11/13/13	82	9,949	2.7
11/14/13	19	1,845	3.4
11/15/13	109	11,768	3.0
11/16/13	131	12,978	3.3
11/18/13	51	5,076	3.3
11/19/13	130	16,587	2.5
11/20/13	135	17,027	2.6
11/21/13	130	12,653	3.3
11/22/13	166	16,760	3.2

	Area North of the No Dredge Zone		
11/23/13	139	16,758	2.7
11/25/13	29	3,113	3.0
11/26/13	146	13,656	3.5
11/29/13	138	13,125	3.4
11/30/13	114	8,637	4.3
12/2/13	169	13,430	4.1
12/5/13	211	12,536	5.5

* Example Thickness Calculation for November 16, 2013 Active/Sand Layer Placement:
Volume of AquaGate+PAC™ Placed = 131 cubic yards (3,545 cubic feet); Area Covered = 12,978 square feet
Effective AquaGate+PAC™ Thickness = 3,345 cubic feet / 12,978 square feet = 0.27 feet = 3.28 inches

Carbon Analysis: Core Sampling and Analytical Results

Carbon content in the applied active/sand layer was evaluated by collecting cores of the layer post-placement at a rate of one core per day (equivalent to approximately one core per ½ acre). The cores were sent intact to the laboratory for analysis of total carbon via Method SM20 5310B-M. Results from the first five cores have been received and are presented in Table 1. The measured carbon values (1.7% to 2.3%) fall within EPA's anticipated +/- 50% of the theoretical mass percentages (see Table 2).

Table 1. Summary of Initial Active/Sand Layer Cores Analyzed for Total Carbon

Sample ID	*Date*	*Total Carbon (mg/kg)*	*Total Carbon (%)*
LPR-COR04A-131118	11/18/2013	17,300	1.7
LPR-COR05A-131119	11/19/2013	22,700	2.3
LPR-COR06A-131120	11/20/2013	22,600	2.3
LPR-COR07A-131122	11/22/2013	20,800	2.1
LPR-COR08A-131123	11/23/2013	17,400	1.7

Table 2. Example Calculations for Theoretical Carbon Weight Percentage

(a) Example Calculation for a 100 ft^3 Sand/AquaGate™ mixture containing 30% (v/v) AquaGate™

Weight of AquaGate™: 100 cu ft x 30% x 72 lb/ ft^3 =	2,160	lbs
Weight of Carbon: 10% by wt. of AquaGate™ =	216	lbs
Weight of Sand: 100 cu ft x (100% - 30%) x 90 lb/ft^3 =	6,300	lbs
Total Weight of 100 ft^3 Mixture =	8,460	lbs
AquaGate™ Weight Percentage =	25.5	%
Carbon Weight Percentage =	2.6	%

(b) Example Calculation for a 100 ft^3 Sand/AquaGate™ mixture containing 25% (v/v) AquaGate™

Weight of AquaGate™: 100 cu ft x 25% x 72 lb/ ft^3 =	1,800	lbs
Weight of Carbon: 10% by wt. of AquaGate™ =	180	lbs
Weight of Sand: 100 cu ft x (100% - 25%) x 90 lb/ ft^3 =	6,750	lbs
Total Weight of 100 ft^3 Mixture =	8,550	lbs
AquaGate™ Weight Percentage =	21.1	%
Carbon Weight Percentage =	2.1	%

Conclusions

All measurements based on the CPG's mass balance approach verify that the active/sand layer placement in the areas both north and south of the No Dredge Zone meet the requirements of the Capping Specifications. These areas are now ready for the next step -- placement of the geotextile liner and armor stone layer.